Improving HWRF and GFDL/GFDN Hurricane Models by Advancing the Air-Sea Interaction Components

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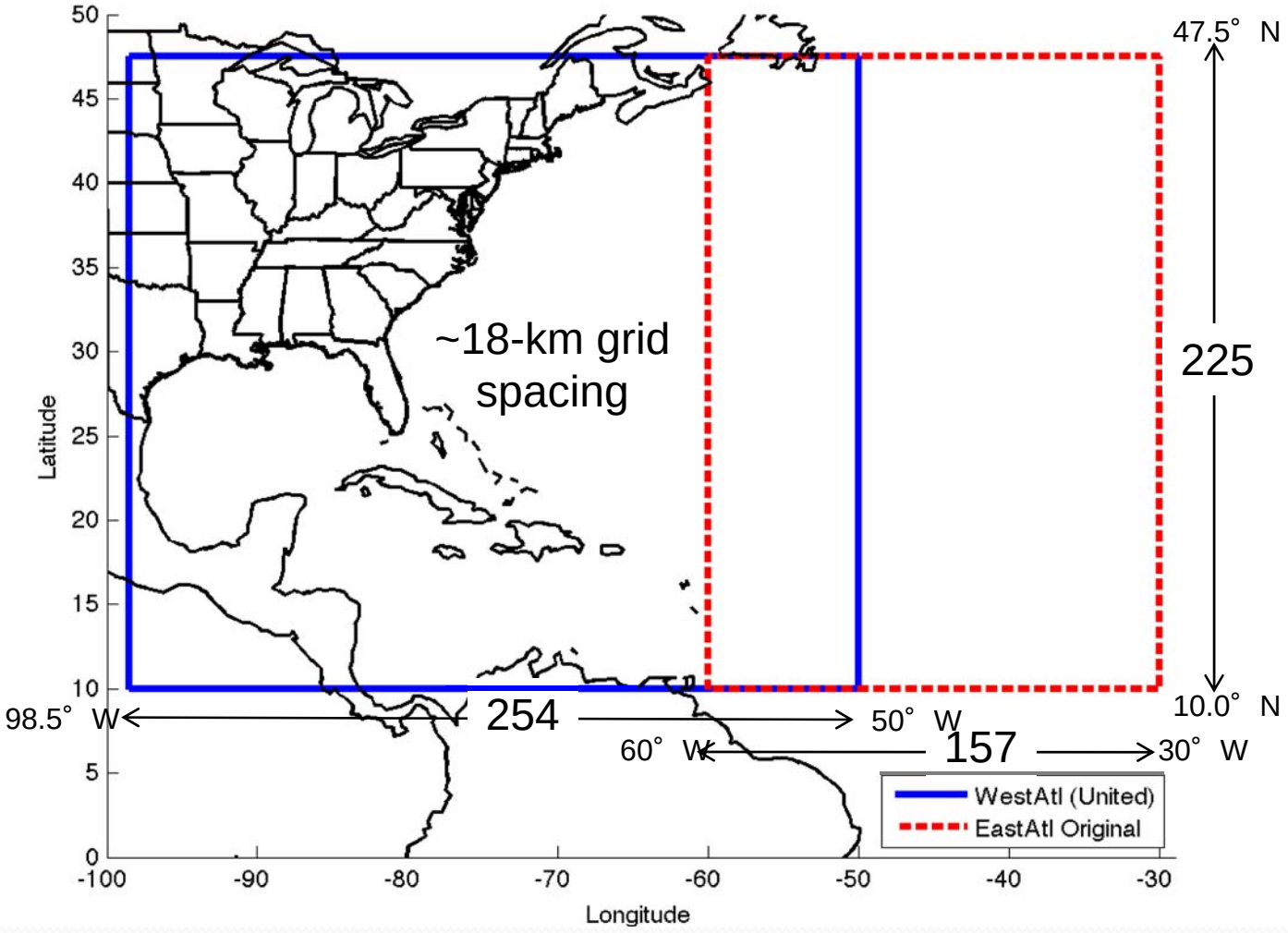
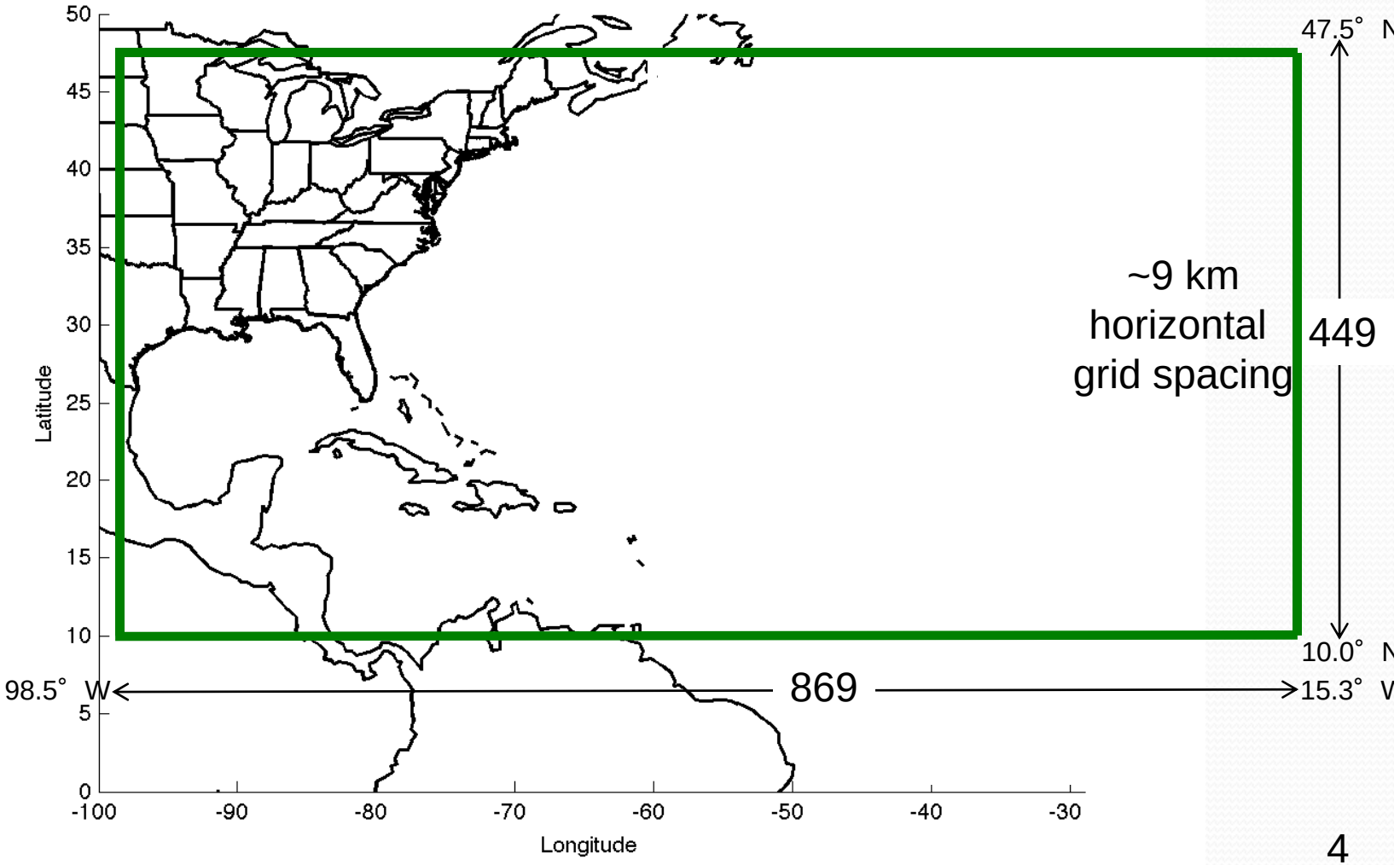
GFDL/N & HWRF Ocean Model Upgrade: Replacing POM-TC with MPIPOM-TC

- MPIPOM-TC uses MPI software to run efficiently on multiple processors, allowing for both higher grid resolution and a larger ocean domain than POM-TC
- MPIPOM-TC accepts flexible initialization options
- MPIPOM-TC is an adaptation of sbPOM, which has community support and includes 18 years of physics updates and bug fixes
- MPIPOM-TC is a modernized code with NetCDF I/O
- MPIPOM-TC uses a single prognostic code in all worldwide GFDL, GFDN, and HWRF ocean basins

POM-TC Atlantic Domains: "United" and "East Atlantic"

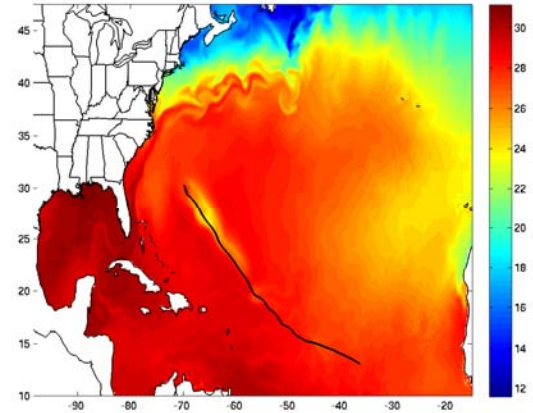


URI's MPIPOM-TC transatlantic domain

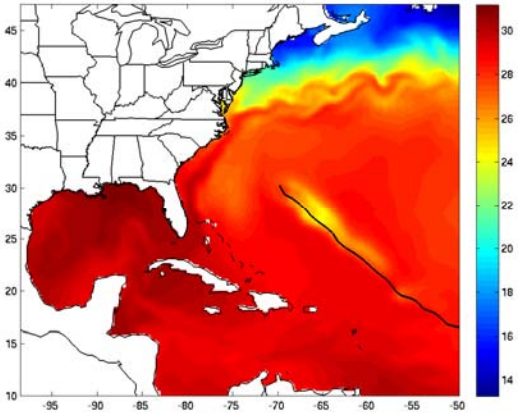


MPIPOM-TC vs. POM-TC: Ocean response to Hurricane Katia (through 2011090800)

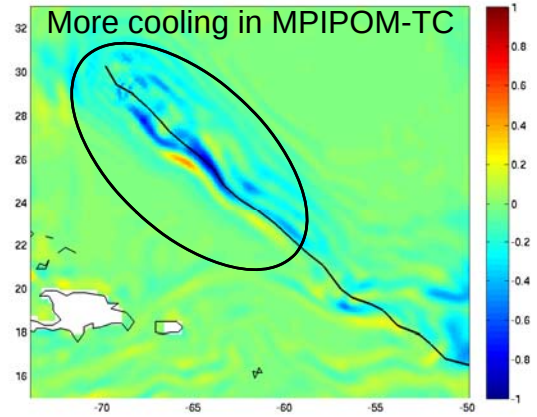
MPIPOM-TC SST (full domain)



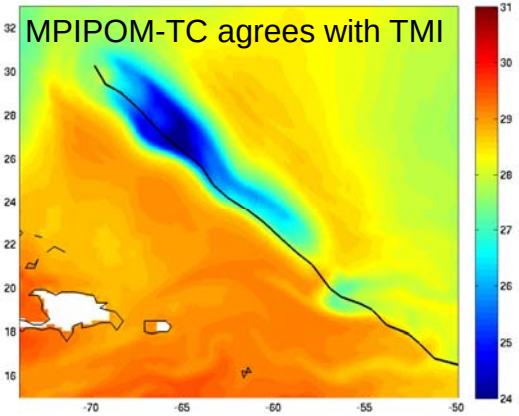
POM-TC SST (full domain)



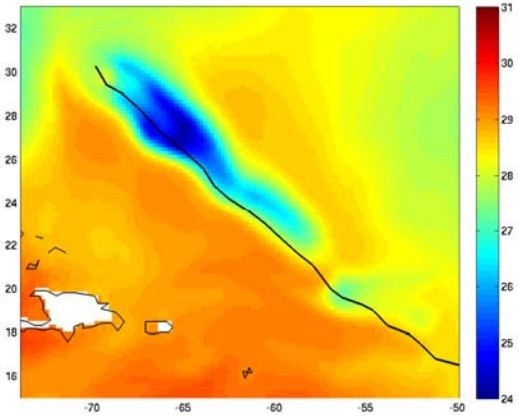
MPIPOM-TC – POM-TC SST



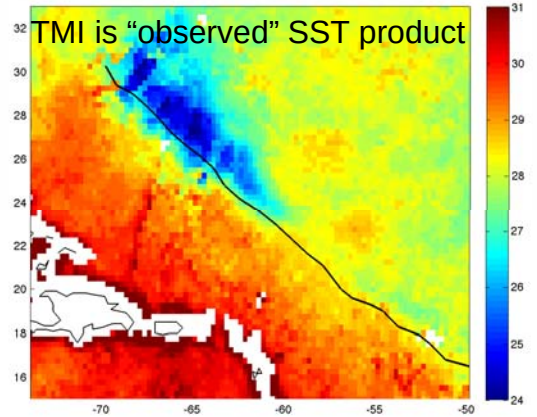
MPIPOM-TC SST (wake only)



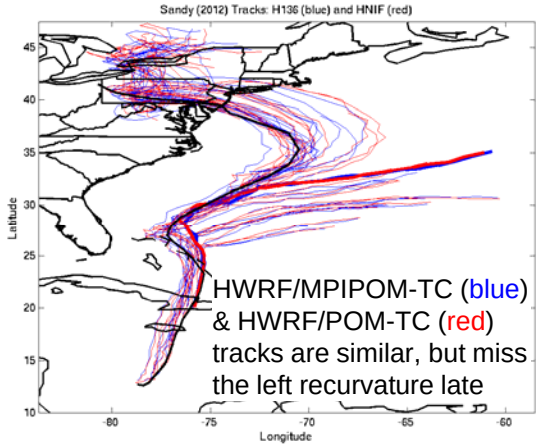
POM-TC SST (wake only)

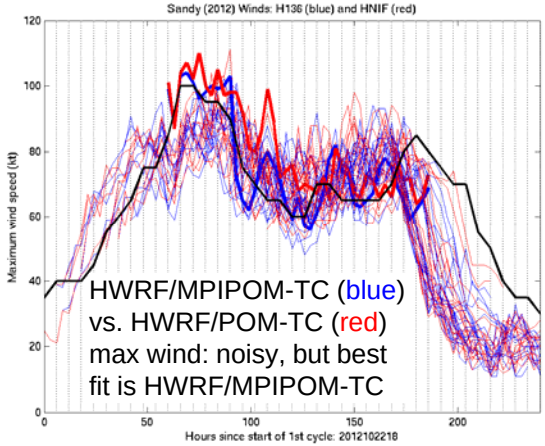


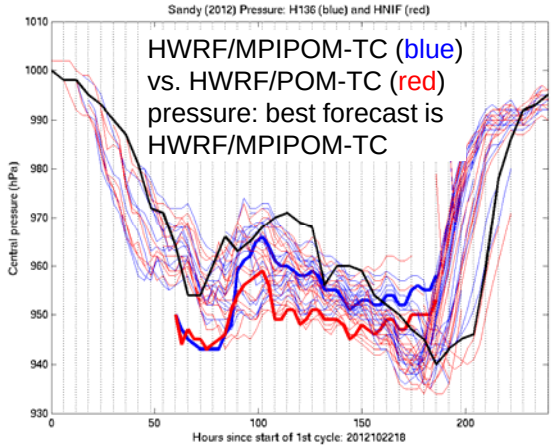
20110908 TMI 3-day SST

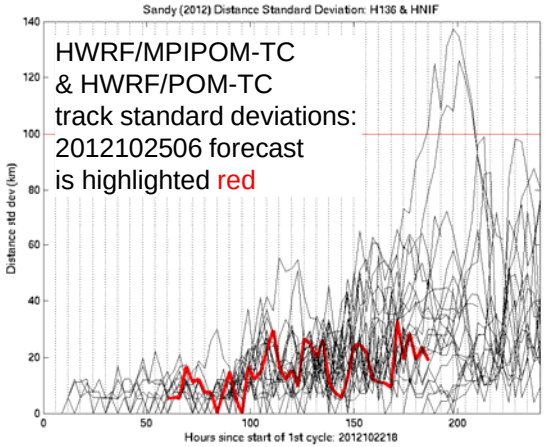


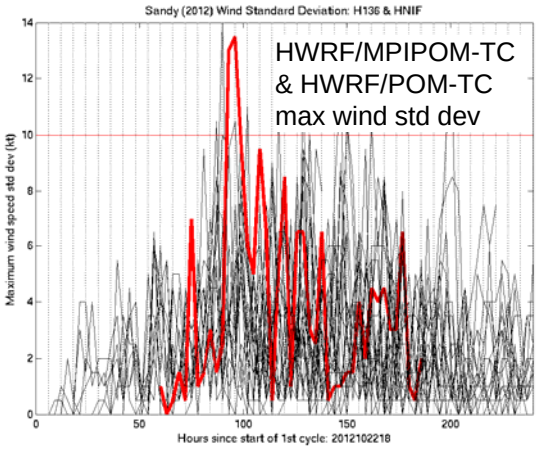
Hurricane Sandy 18L: 2012102506

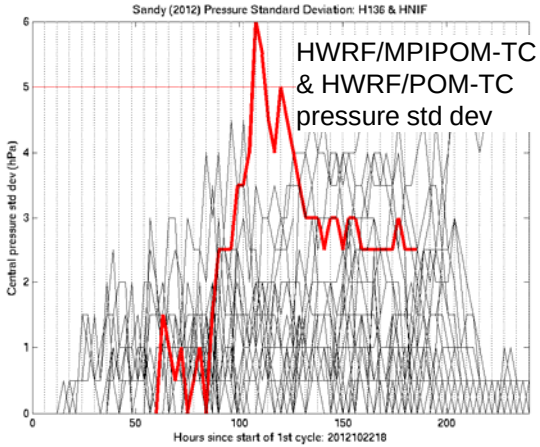












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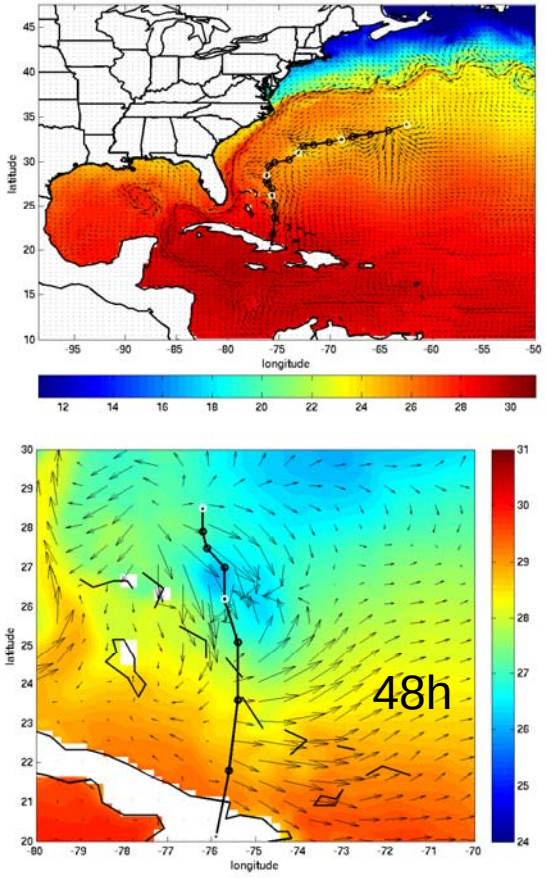
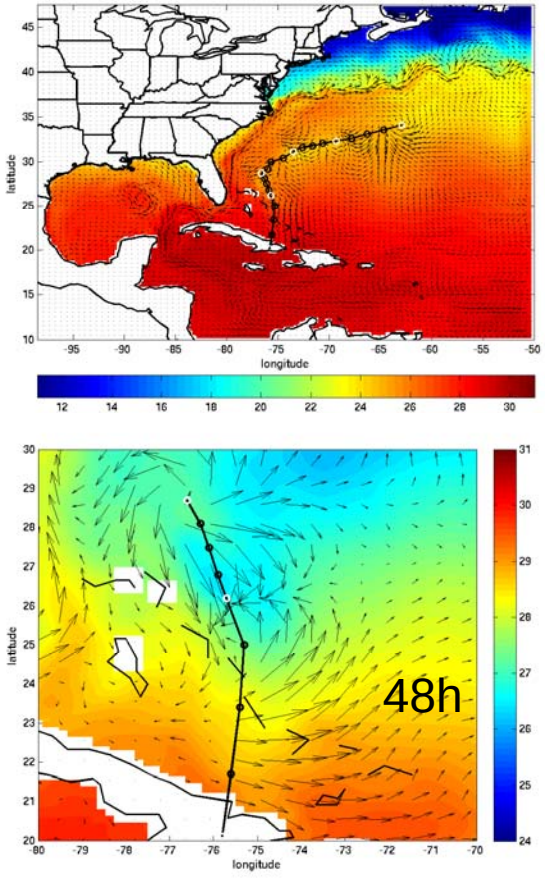
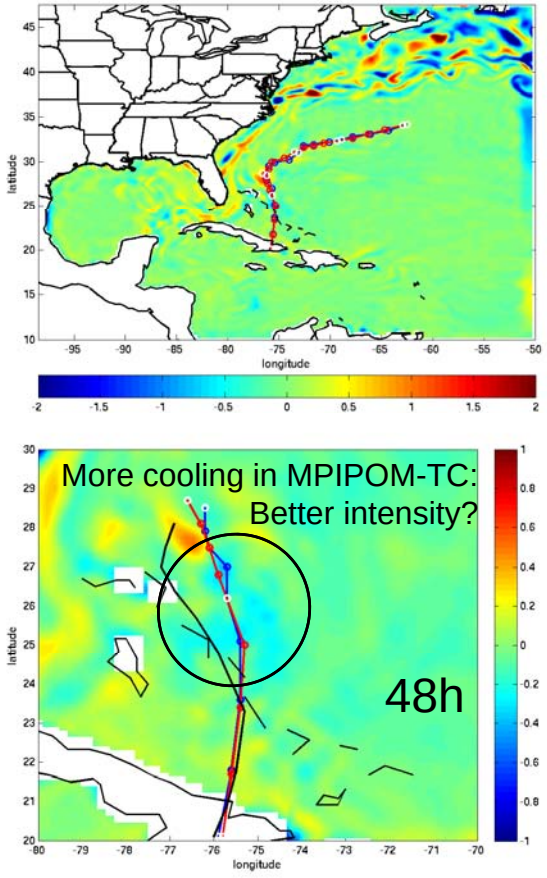


MPIPOMTC SST + Currents

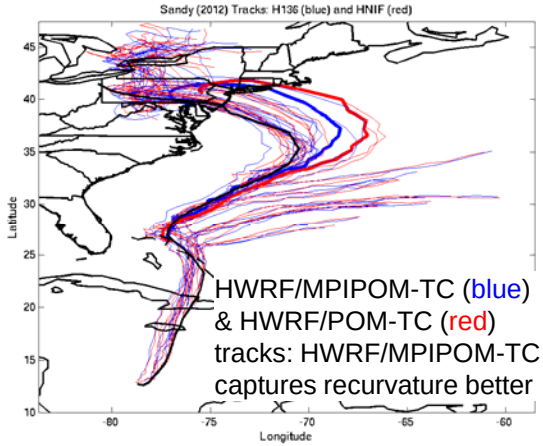


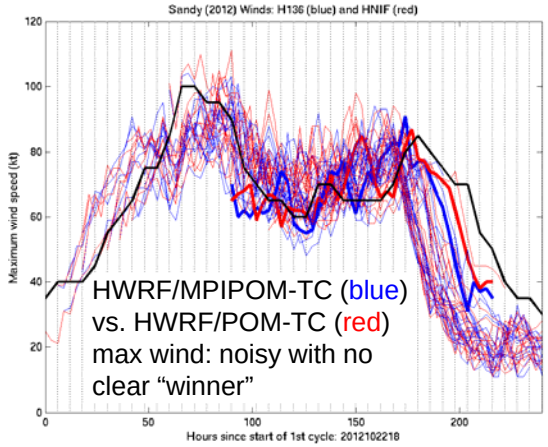
POM-TC SST + Currents

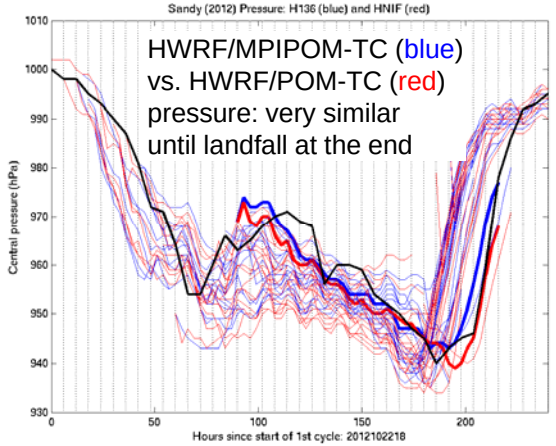


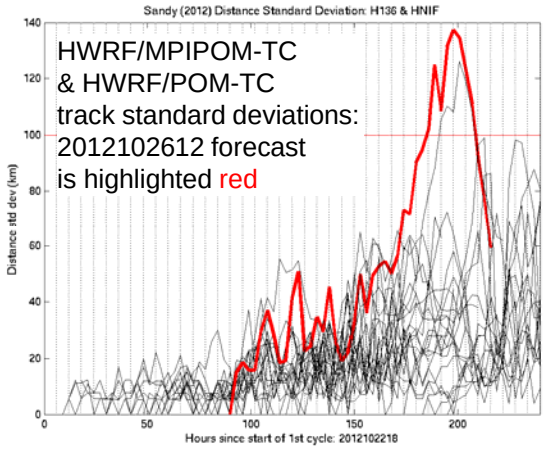
MPIPOMTC – POM-TC SST

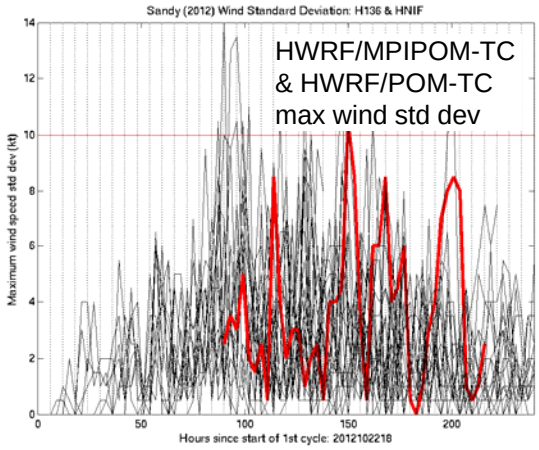
Hurricane Sandy 18L: 2012102612

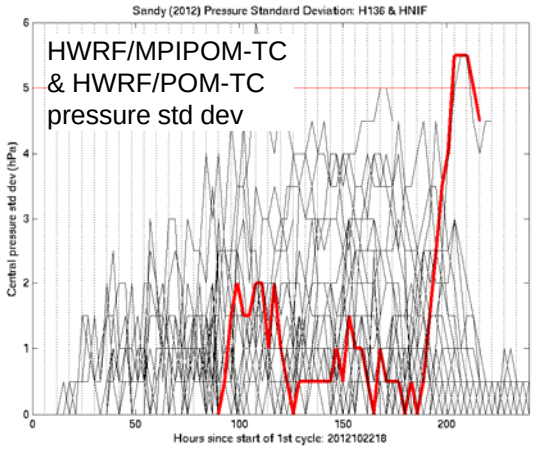




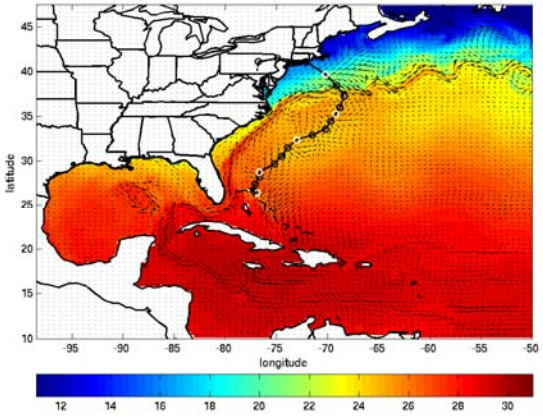




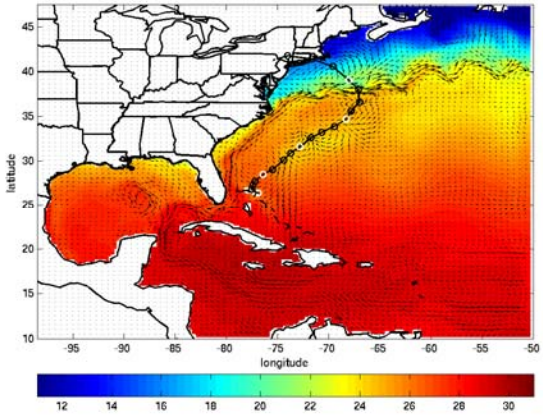




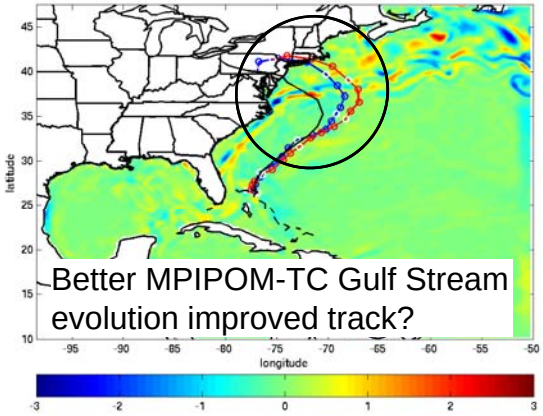
Hurricane Sandy 18L: 2012102612



MPIPOMTC SST + Currents

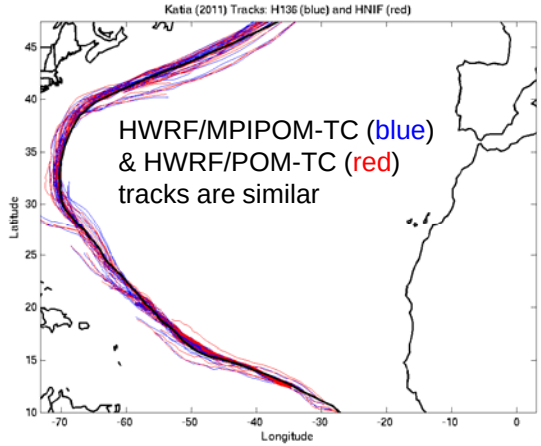


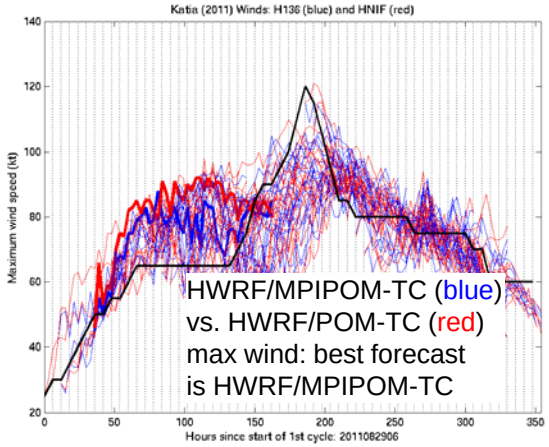
POM-TC SST + Currents

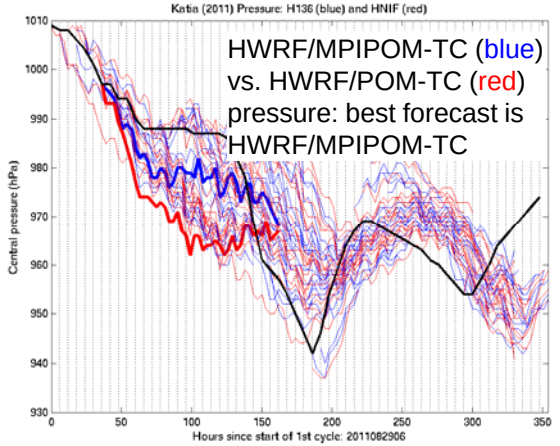


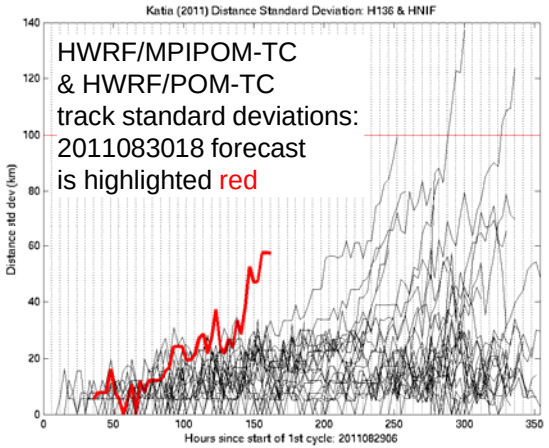
MPIPOMTC – POM-TC SST

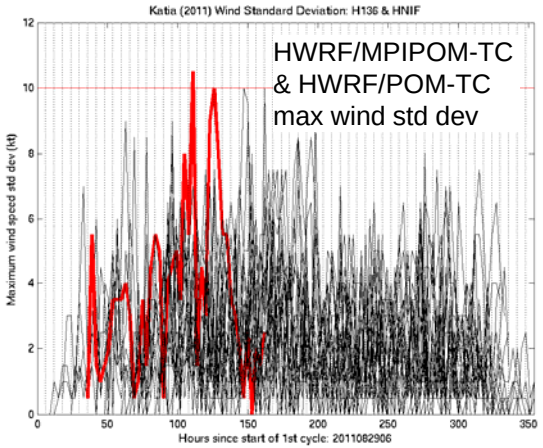
Hurricane Katia 12L: 2011083018

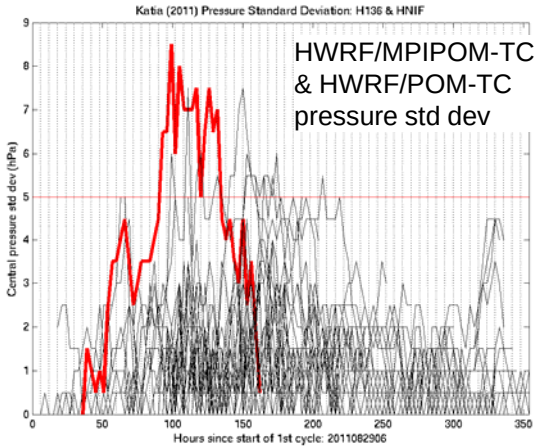




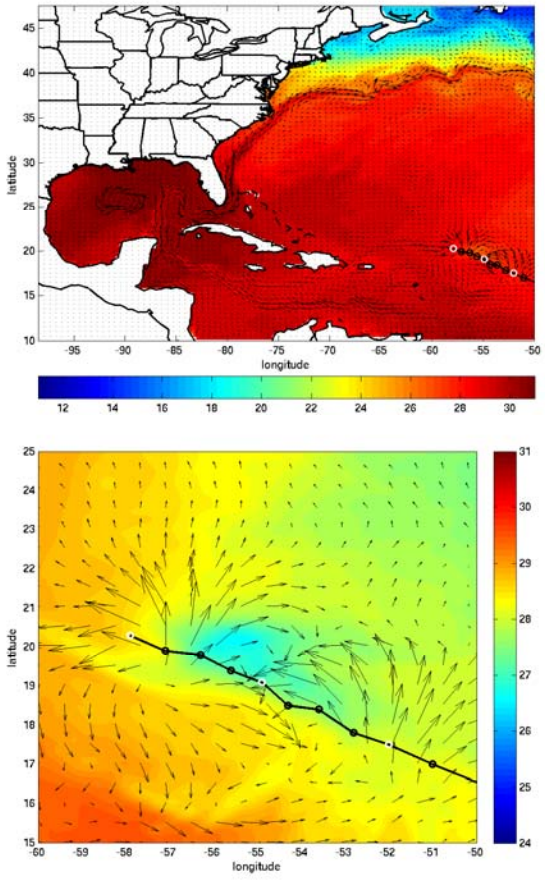




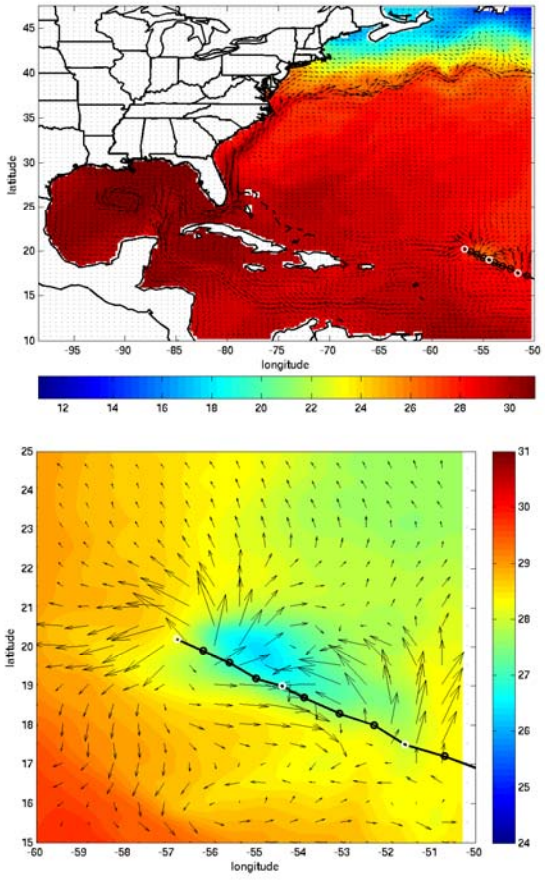




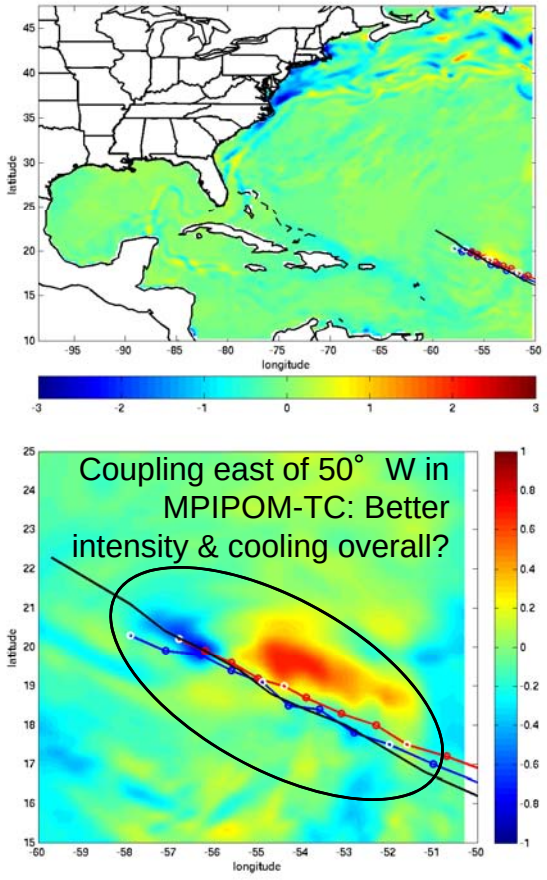
Hurricane Katia 12L: 2011083018



MPIPOMTC SST + Currents

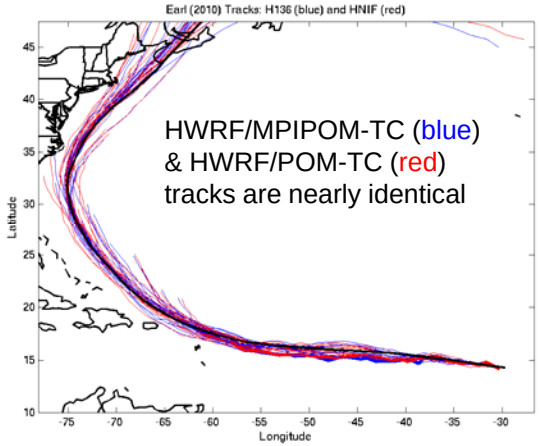


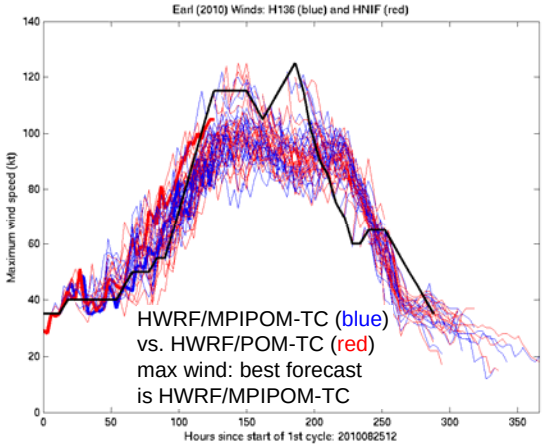
POM-TC SST + Currents

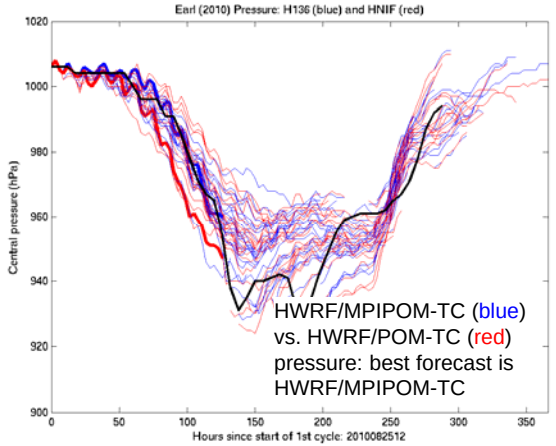


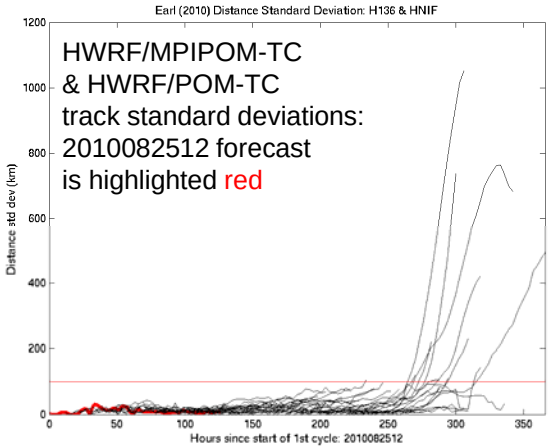
MPIPOMTC – POM-TC SST

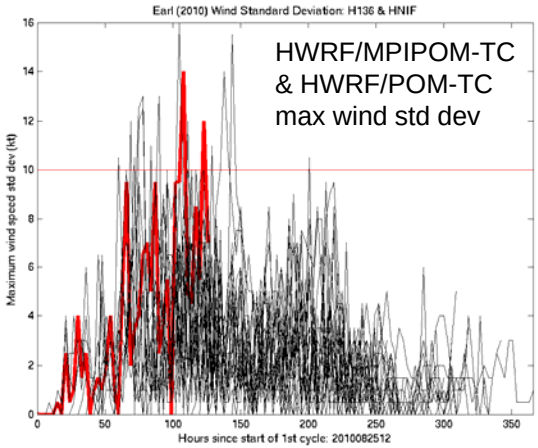
Hurricane Earl 07L: 2010082512

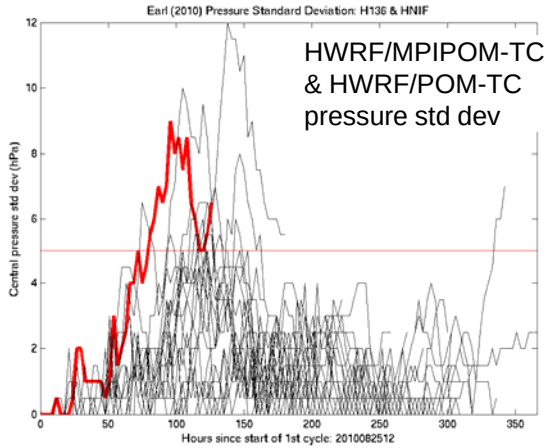




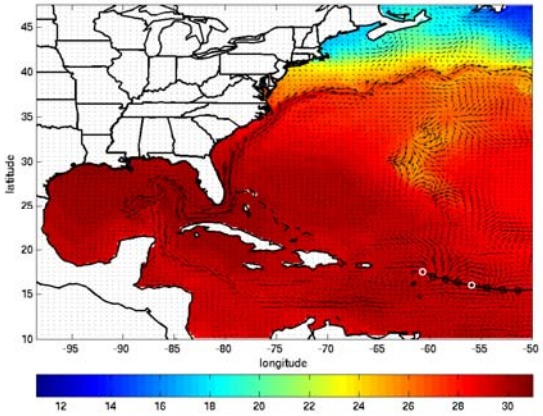




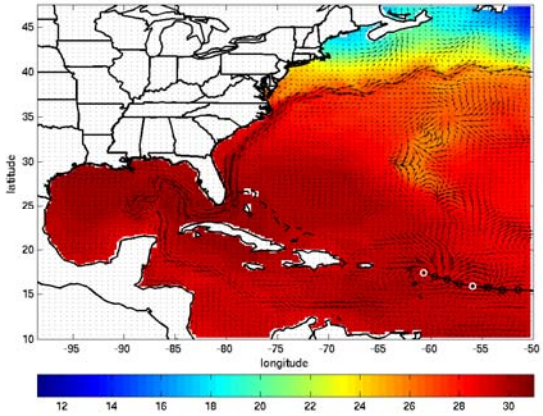




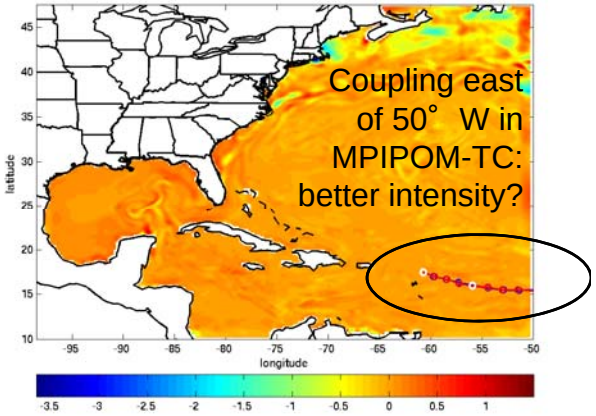
Hurricane Earl 07L: 20100825 12 & 18 Z



MPIPOMTC SST + Currents

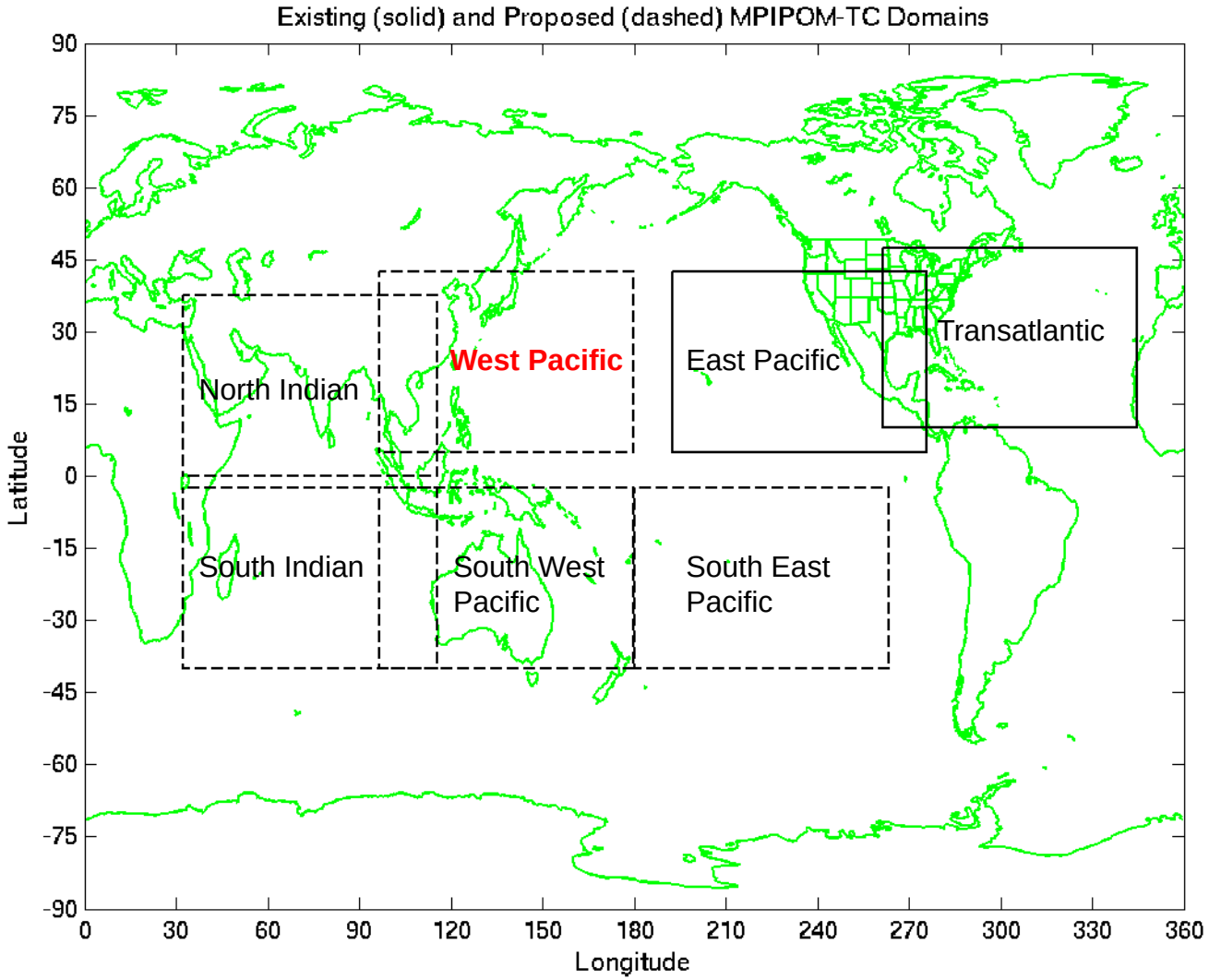


POM-TC SST + Currents

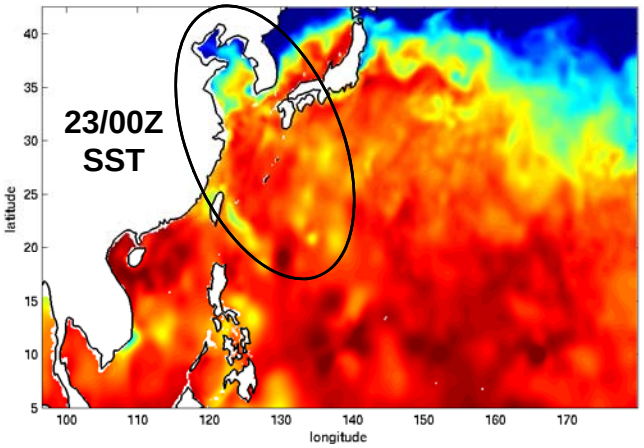


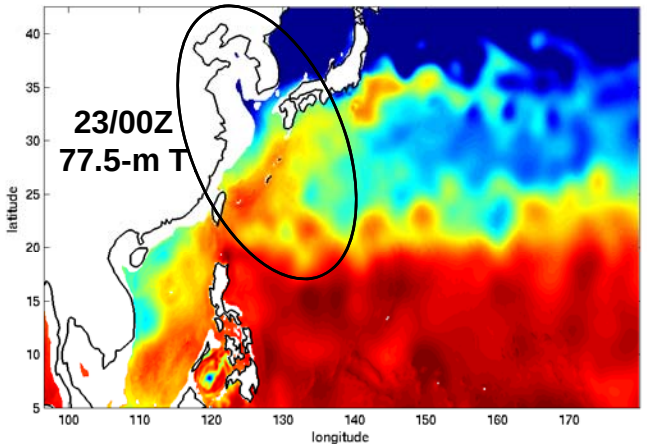
MPIPOMTC – POM-TC SST

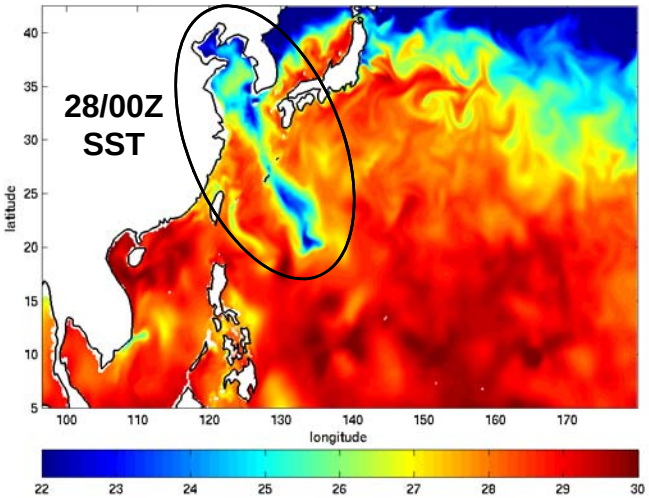
Proposed Worldwide MPIPOM-TC domains

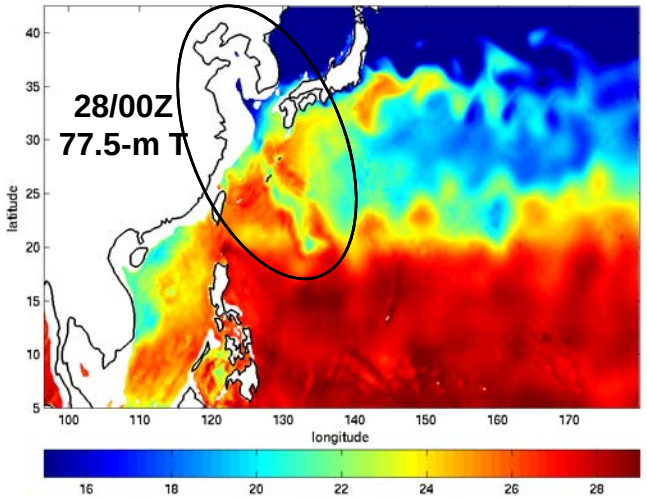


URI's MPIPOM-TC West Pacific Domain: Ocean Response to Supertyphoon Bolaven with NCODA initialization: 2012082300-2800

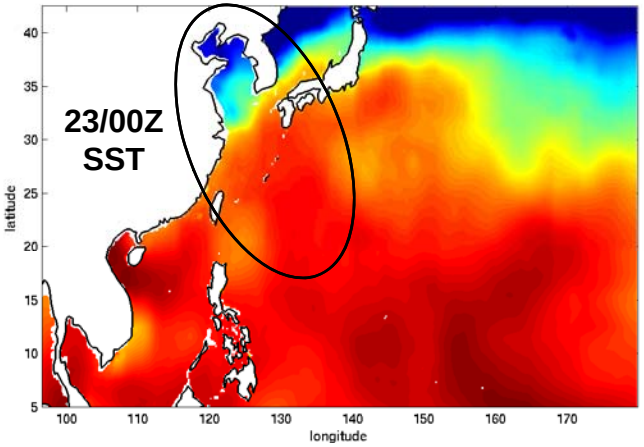


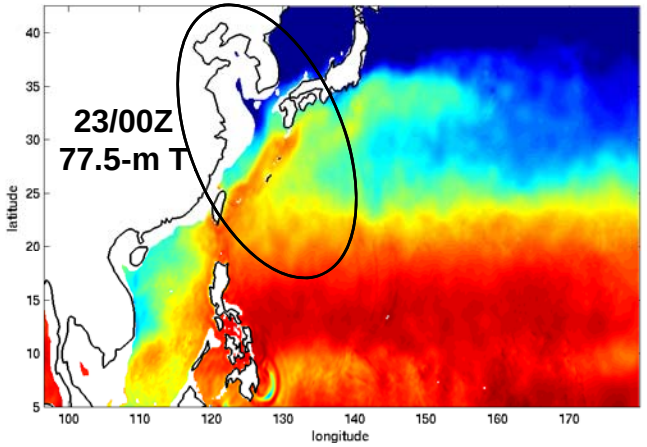


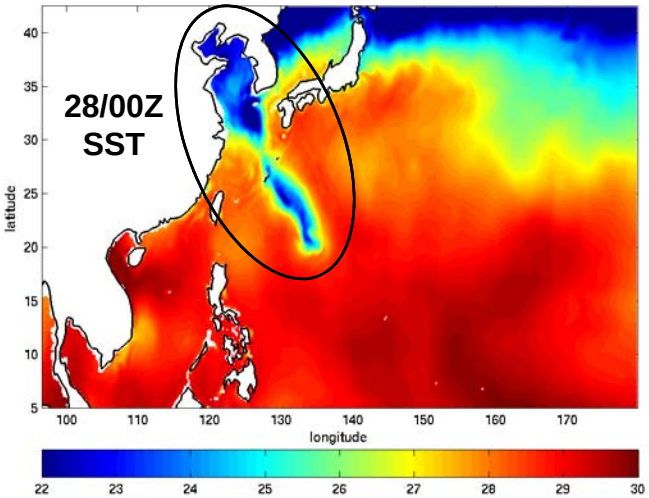


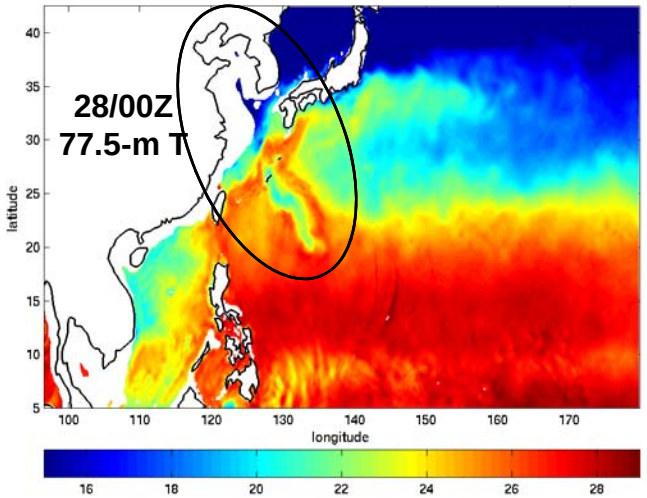


URI's MPIPOM-TC West Pacific Domain: Ocean Response to Supertyphoon Bolaven with GDEMv3 + GFS SST initialization: 2012082300-2800

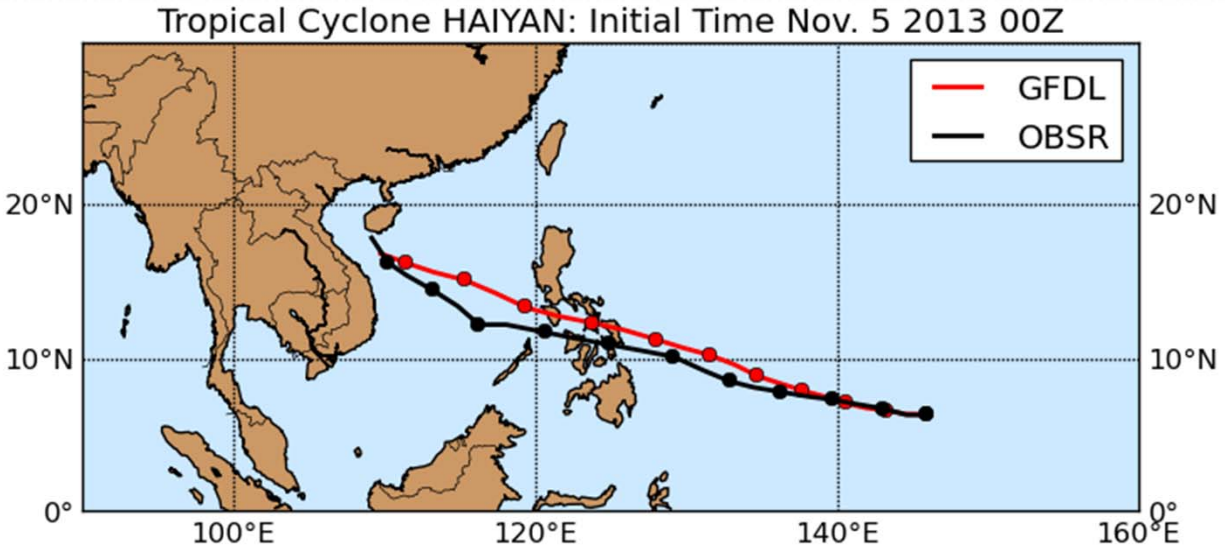


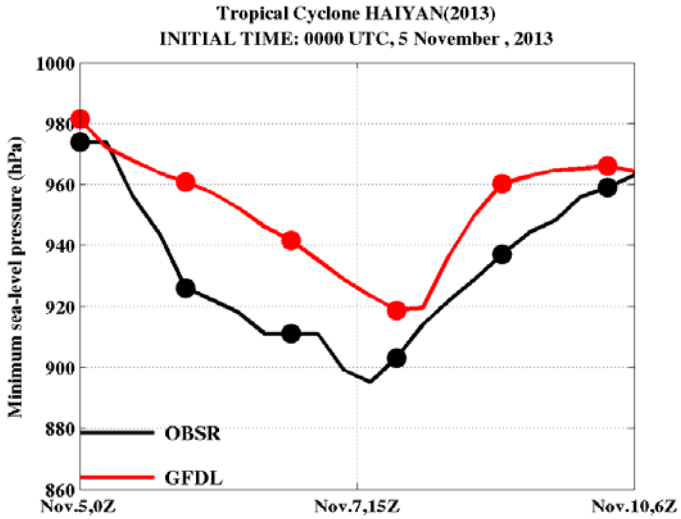


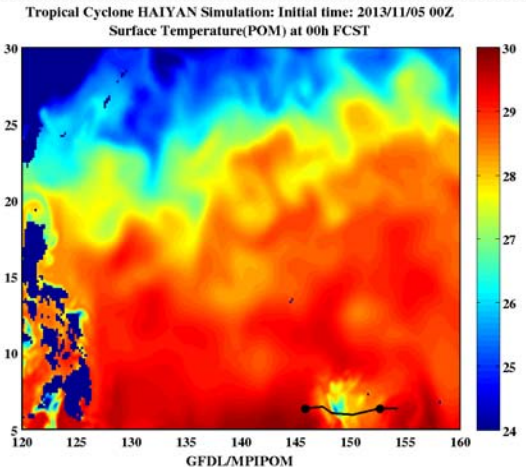


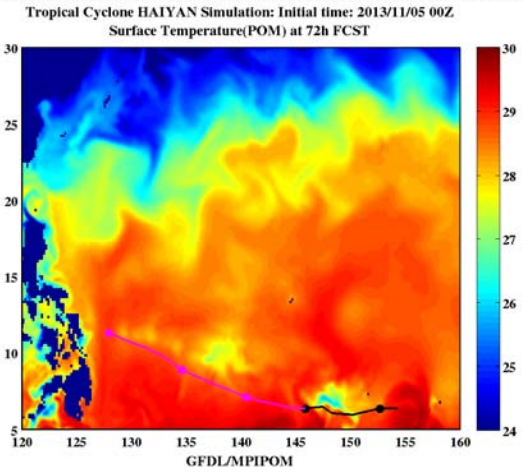


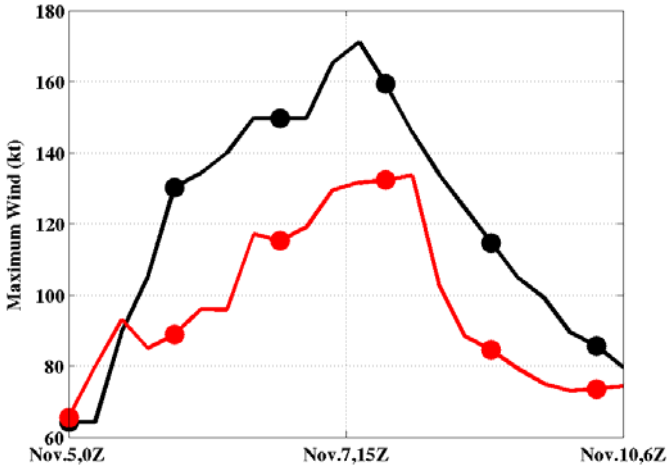
GFDL/MPIPOM-TC retrospective forecast of Supertyphoon Haiyan, initialized 2013110500 (NCODA)



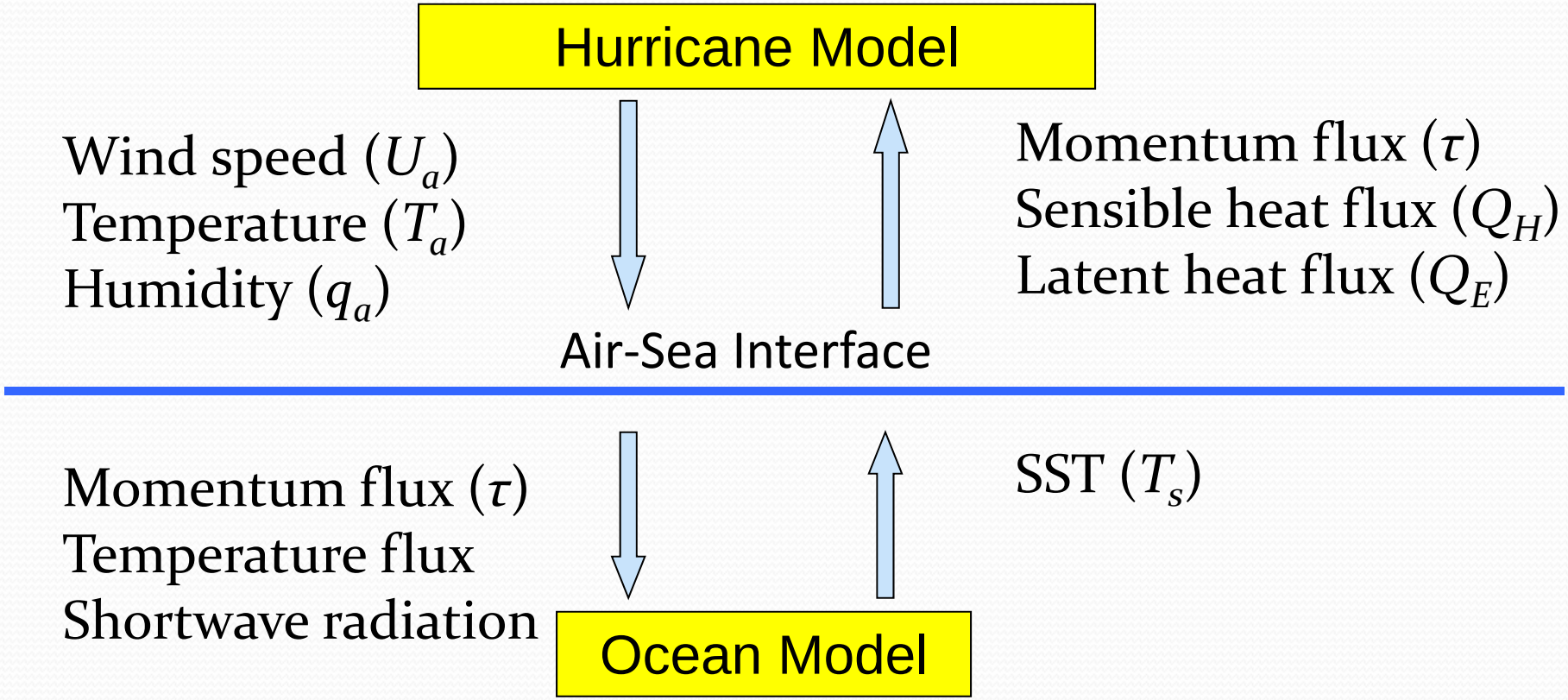






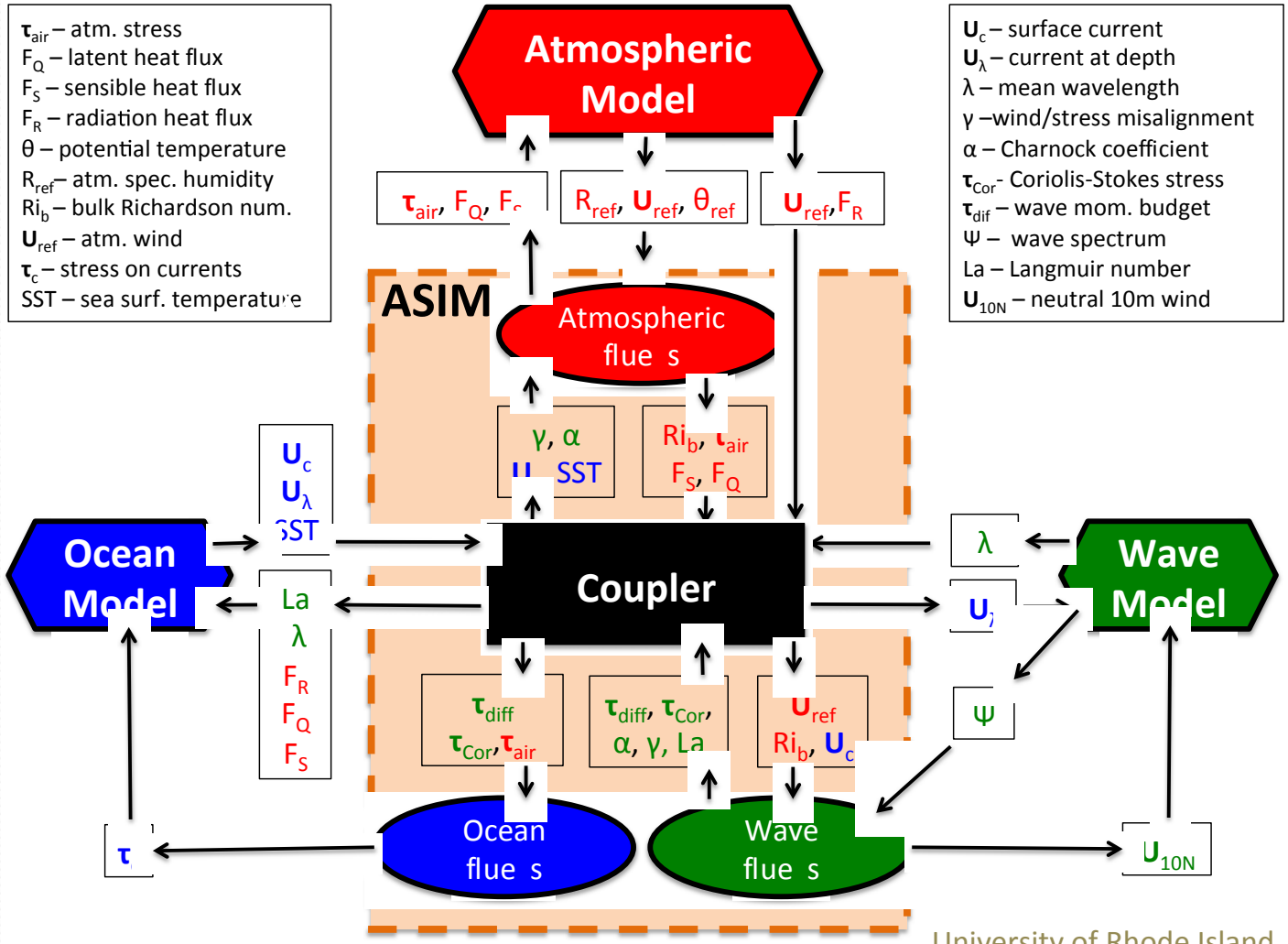


GFDL/N and HWRF Ocean Coupling

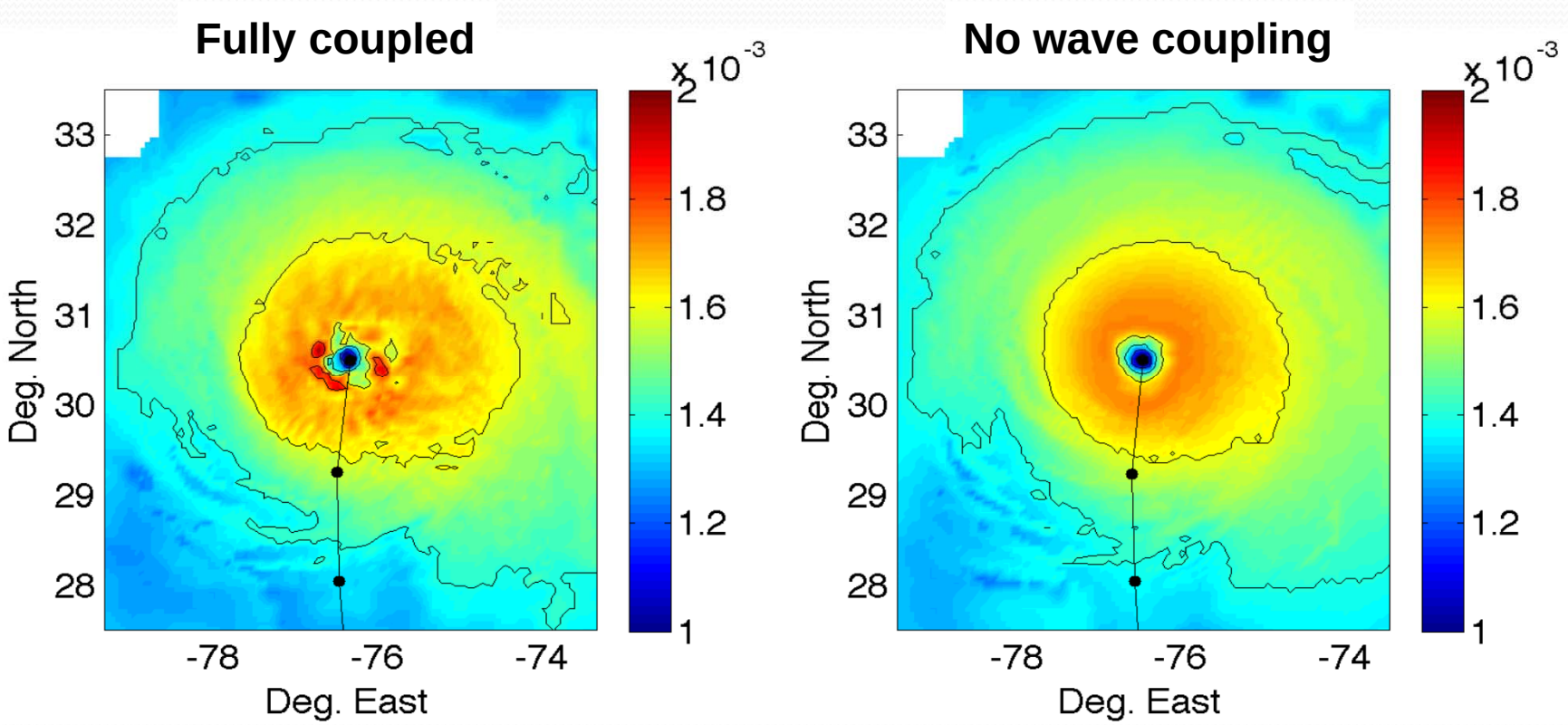


$$\tau = \rho_a C_D U_a U_a \qquad Q_H = C_H U_a (T_a - T_s) \qquad Q_E = \frac{L_V}{C_P} C_E U_a (q_a - q_s)$$

Atmosphere-Wave-Ocean Coupled Framework for GFDL/N and HWRF models

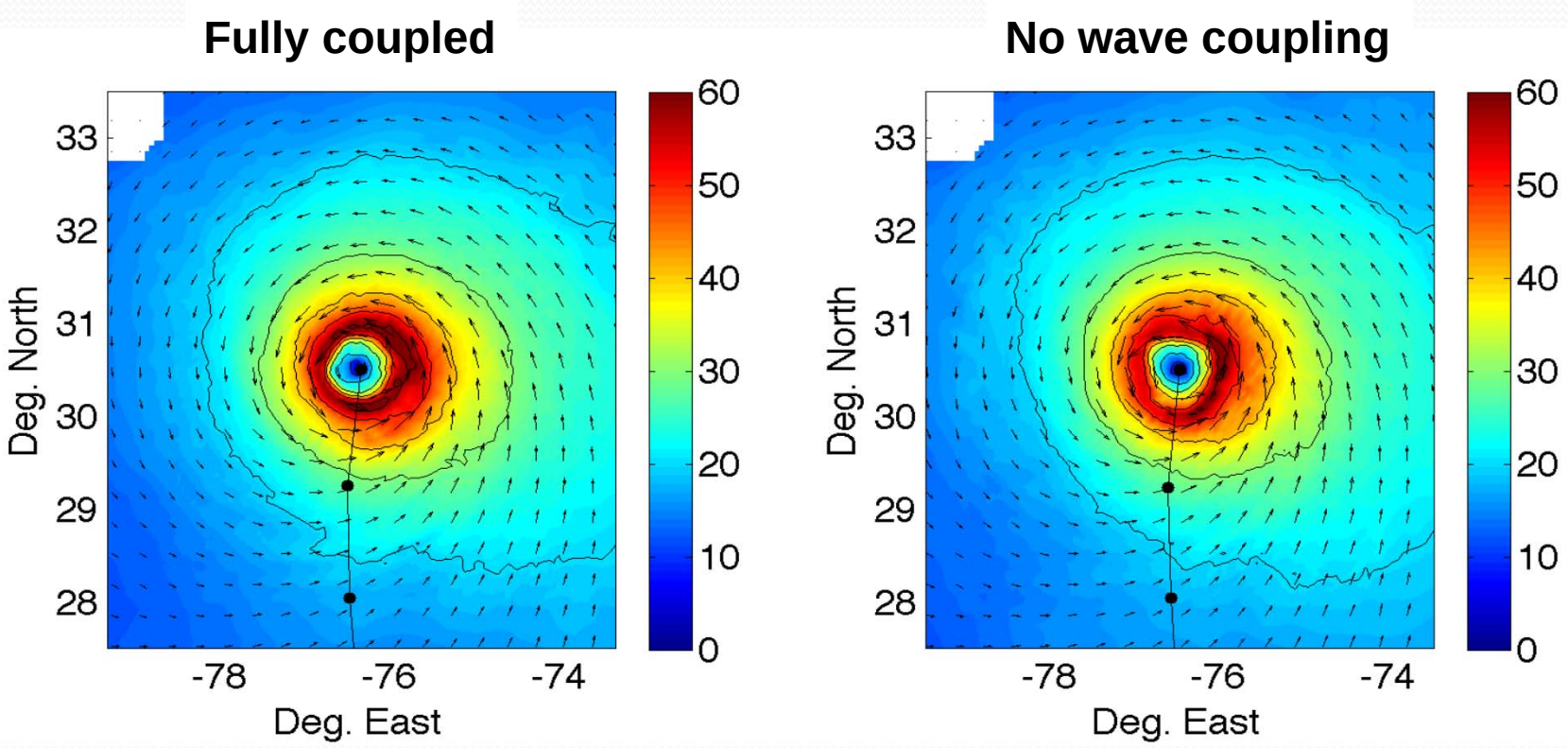


GFDL/(WWIII)/POM-TC 72-h Forecast of Hurricane Irene (2011082612)



35-m Drag Coefficient

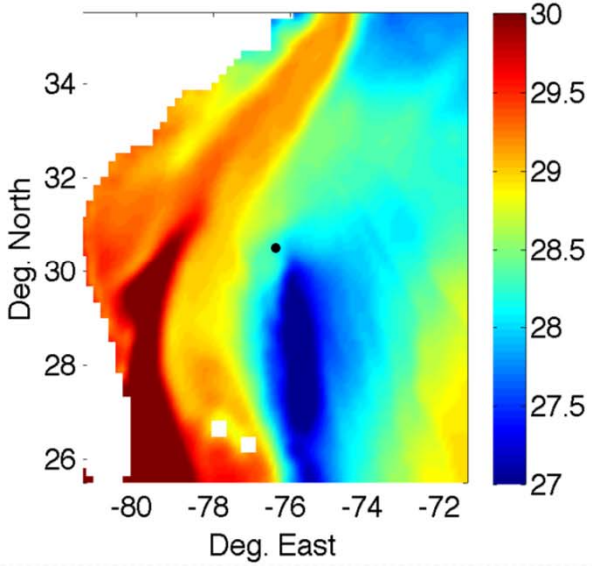
GFDL/(WWIII)/POM-TC 72-h Forecast of Hurricane Irene (2011082612)



35-m Wind (m/s)

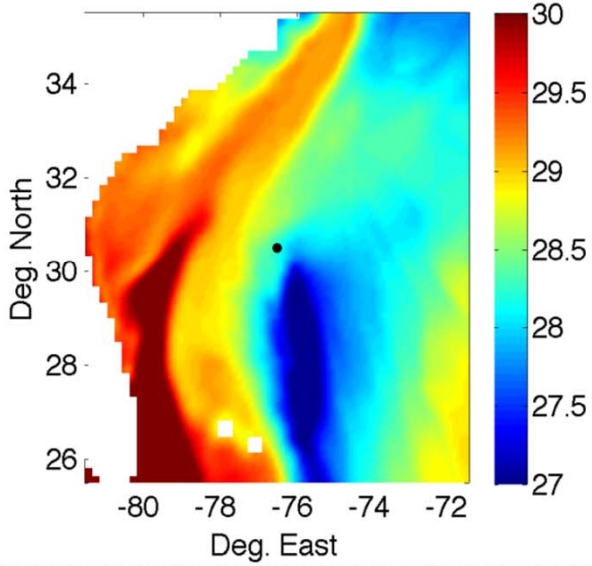
GFDL/(WWIII)/POM-TC 72-h Forecast of Hurricane Irene (2011082612)

Fully coupled



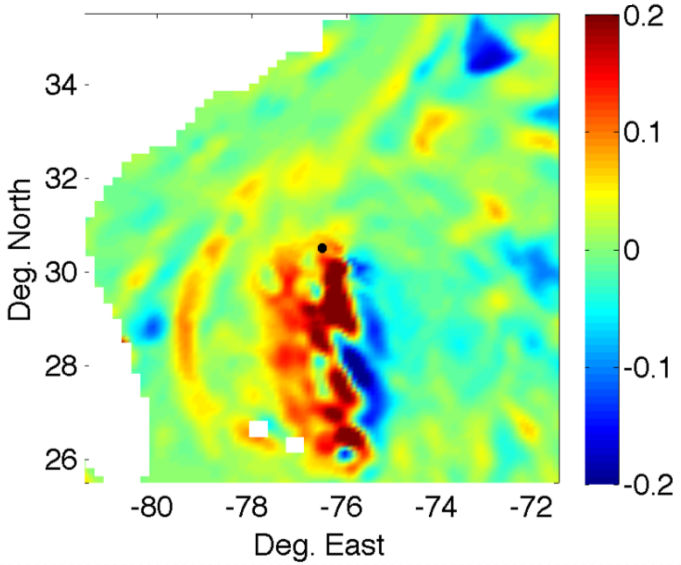
SST (ºC)

No wave coupling



SST (ºC)

Fully coupled – No wave



ΔSST (ºC)

Summary

- Major 2014 upgrade of the GFDL/N and HWRF ocean model components: Replacing POM-TC with MPIPOM-TC.
- Alternative MPIPOM-TC ocean initialization options are being evaluated and tested for future implementation.
- A fully coupled atmosphere-wave-ocean framework has been developed for the GFDL/N and HWRF models to explicitly resolve effects of wind-wave-current interactions.
- The next step is to investigate the influence of explicit wave coupling on hurricane prediction. Near real-time test runs are planned in 2014.